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Presented by the Author

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PRINCIPAL CHARACTERS OF THE DINOCERATA.

PART I.

BY PROFESSOR O. C. MARSH.

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The huge Eocene mammals, discovered by the writer in 1870, and subsequently placed in the new order *Dinocerata*, prove to be a well marked group of much interest. The Yale College Museum now contains remains of more than a hundred individuals, some of them in such excellent preservation that few points in the osseous structure of these animals need longer remain in doubt. It is proposed, therefore, to give, in the present communication, the more important characters of the members of this order, reserving the detailed description for a separate memoir. Although several distinct genera of *Dinocerata* are now known, as shown below, the typical characteristics of the group are best seen in *Dinoceras*, and hence I describe first that genus, which is especially illustrated in the accompanying plates.

Dinoceras Marsh, 1872.*

The skull in *Dinoceras* is long and narrow, the facial portion being greatly produced. The basal line, extending from the lower margin of the foramen magnum along the palate to the end of the premaxillaries, is nearly straight. The top of the skull supports three separate transverse pairs of osseous elevations, or horn-cores, which form its most conspicuous feature, and suggested the name of the genus. The smallest of these protuberances are situated near the extremity of the nasals; a second much larger pair rise from the maxillaries in front of the orbits; while the largest are on the parietals, and supported by an enormous crest, which extends from near the orbits entirely around the lateral and posterior margins of the true cranium. (Plate II.) The posterior crest, which curves upward and backward beyond the occipital condyles, is mainly composed of the supra-occipital. The floor of the deep depression in front of this crest is formed by the parietals These bones also send up the lateral crests. The top of the skull between the orbits is formed of the frontal bones, which are remarkably short. Their superior sutures with the parietals pass just in front of the lateral crest, and then converge posteriorly. There is no postorbital process, but in some species of

* This Journal, iv, 343, v, 117, 293 and 310.

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the genus there is a prominence on the frontal, directly over the orbit. The nasals are greatly elongated, being nearly half the length of the entire skull. They unite with the frontals by oblique sutures, directed backward and inward, and nearly parallel with the superior fronto-parietal sutures. (Plate II, figure 3.) The osseous protuberances on the extremities of the nasals are of moderate size in *Dinoceras*, but, like the maxillary horn-cores, vary much with age. Both may possibly have been covered with thick skin, and not with true horns.

The orbit is large, and confluent with the temporal fossa. The latter is of great extent posteriorly, but the zygomatic arches are only moderately expanded. The squamosal forms the lower portion of the temporal fossa, and sends down a massive post-glenoid process, which bounds in front the external auditory meatus. The latter has for its posterior border the post-tympanic process of the squamosal, which unites directly with the paroccipital, thus excluding the mastoid from the external surface of the skull, as in *Rhinoceros*. The tympanic portion of the periotic, also, does not reach this surface. There are small air-cells in the walls of the temporal fossa, both in the squamosal and parietals. The squamosal sends forward a strong zygomatic process, which resembles that in *Tapirus*. The malar completes the anterior portion of the arch, extending to the front of the orbit. (Plate II, figure 1.) The lachrymal is large, and forms the anterior border of the orbit. It is perforated by a large foramen. The maxillaries are massive, and quite remarkable in supporting a pair of stout, conical horn-cores, which vary in form and size in different species. These cones are solid except at the base, which is usually perforated for the fang of the canine tusk. The premaxillaries are elongated, and without teeth. They unite posteriorly with the maxillaries just in front of the canine, and then divide, sending forward two branches, which partially enclose above and below the lateral portion of the narial aperture. (Plate II, figure 1.) The lower portion is slender, and resembles the premaxillary of some Ruminants. The premaxillaries are not united at their extremities. The latter are rough, and probably supported a pad.

The palate is very narrow and deeply excavated, especially in front. The anterior palatine foramina are in the premaxillaries, and vary much in different species. In *D. mirabile* they are elongated fissures, enclosed between the lateral and palatine branches of the premaxillaries, as in *Equus*. In *D. laticeps* they are of small size, and oval in outline. The posterior palatine foramina are in the maxillaries near the anterior border, as in *Hippopotamus*. The posterior nares extend forward between the last upper molars. The occipital condyles are large, and bounded externally in front and below by a deep groove. They

project downward and backward, showing that the head was declined when in its natural position. The exoccipitals are perforated by a condylar foramen of moderate size, which is separated from the larger foramen lacerum posterius by a slender partition of bone. Between the post-glenoid process and the basi-sphenoid, there is an irregular cavity filled in part below by the periotic. There is a distinct alisphenoid canal, and the foramen ovale is near its posterior orifice. In front of its anterior opening, is a small foramen lacerum anterius, and further forward, the optic foramen. The infraorbital foramen is large, and partially concealed behind the maxillary ridge which supports the malar.

The brain cavity in *Dinoceras* is perhaps the most remarkable feature in this remarkable genus. It proves conclusively that the brain was proportionately smaller than in any other known mammal, recent or fossil, and even less than in some reptiles. It was, in fact, the most reptilian brain in any known mammal. In *D. mirabile*, the entire brain was actually so diminutive that it could apparently have been drawn through the neural canal of all the presacral vertebræ, certainly through the cervicals and lumbars. The size of the entire brain as compared with that of the cranium is well shown in the accompanying cut, figure 1.

1.

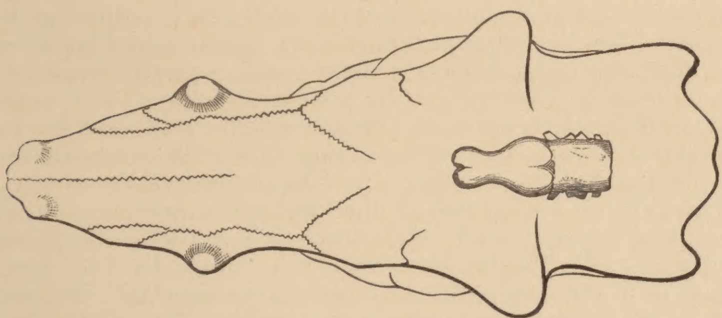


Figure 1. Outline of Skull and Brain Cavity of *Dinoceras mirabile*. Top view; one-eighth natural size.

The most striking feature in the brain cavity itself is the relatively small size of the cerebral fossa, this being but little larger than the cerebellar portion. This is shown in Plate IV, the figures of which are drawn from a cast of the brain cavity of *D. mirabile*, the type of the genus. The cerebral hemispheres did not extend at all over either the cerebellum or the olfactory lobes. The latter were large, and continued well forward. The hemispheres were apparently convoluted, and the Sylvian fissure distinctly marked. There was a rudimentary

tentorial ridge. The cerebellar fossa is but little larger transversely than the medullar canal, and has lateral cavities which may have been occupied by flocculi. The pituitary fossa is nearly round, and of moderate depth. There are no clinoid processes. The brain as a whole resembled that in some Marsupials more than in any other known mammals. Its small size, as the writer has elsewhere shown, is a character apparently pertaining to all Eocene mammals;* the brain-growth during the rest of the Tertiary period having been gradual, and mainly in the cerebrum.

The teeth in *Dinoceras* are represented by the following formula:

$$\text{Incisors } \frac{0}{3}; \text{ canines } \frac{1}{1}; \text{ premolars } \frac{3}{3}; \text{ molars } \frac{3}{3}; \times 2 = 34.$$

The superior canines are long, decurved, trenchant tusks. They are covered with enamel, and their fangs extend upward into the base of the maxillary horn-cores. There is some evidence that these tusks were small in the females. Behind the canine, there is a moderate diastema. The molar teeth are very small. The crowns of the superior molars are formed of two transverse crests, separated externally, and meeting at their inner extremities. The series is well shown in Plate III, which represents the upper premolars and molars of *D. mirabile.* The first true molar is smaller in this specimen than the two preceding premolars. The last upper molar is much the largest of the series.

The lower jaw in *Dinoceras* is as remarkable as the skull. Its most peculiar features are the posterior direction of the condyles, hitherto unknown in Ungulates, and a massive decurved process on each ramus, extending downward and outward below the diastema. (Plate V.) The position of the condyles was evidently necessitated by the long upper tusks, as, with the ordinary ungulate articulation, the mouth could not have been fully opened. The low position of the condyle, but little above the line of the teeth, is also a noteworthy character. The long pendant processes were apparently to protect the tusks, which would otherwise be very liable to be broken. Indications of similar processes are seen in *Smilodon*, and some other Carnivores with long upper canines. With the exception of these processes, the lower jaw of *Dinoceras* is small and slender. The symphysis is completely ossified. The six incisors were contiguous, and all directed well forward. Just behind these, and not separated from them, was the small canine, which had a similar direction. The crowns of the lower molars have transverse crests, and the last of the series is the largest. (Plate V, figure 3.)

The vertebræ in *Dinoceras*, in their main characters, resemble

* This Journal, viii, p. 66, July, 1874.

those of Proboscidians. The atlas and axis are very similar to those of the elephant, but the rest of the cervicals are proportionally longer. The dorsal and lumbar vertebræ have the articular faces nearly flat, and the lumbars have an inferior ridge on the median line. There are four sacral vertebræ, the last being quite small. The anterior caudals have long, depressed, transverse processes. The ribs resemble those in *Mastodon*. The segments of the sternum were well ossified, and most of them were flattened vertically.

The scapula, in its general form, is similar to that of the elephant, but there is much less constriction above the glenoid fossa. The latter is elongate, deeply concave longitudinally, and nearly flat transversely. The spine extends downward nearly to the glenoid border. The coracoid portion is a rugose protuberance, separate from the margin of the articular fossa. The humerus is short and massive, and in its main features resembles that of the elephant. One of the most marked differences is seen in the great tuberosity, which does not rise above the head, and is but little compressed. The condylar ridge, moreover, of the distal end is tubercular, and not continued upward on the shaft. The lower extremity of the humerus is much like that of the rhinoceros, and the proportions of the two bones are essentially the same. The radius and ulna are nearly of the same size. The head of the radius rests on the middle of the ulnar articulation, and hence the shaft of this bone does not cross that of the ulna so obliquely as in the elephant. The ulna has a small face for articulation with the lunar, as in the elephant.

There are five well developed toes in the manus, which is well shown in Plate VI, figure 2. The carpal bones are eight in number, and form interlocking series, as in Perissodactyls. The scaphoid resembles that bone in the elephant, but is shorter and stouter. Its proximal end is rounded, forming about one-fourth of a sphere. On its distal end, the articular faces are confluent. It supports the trapezium and trapezoid. The pyramidal sends down an outer angle to articulate with the fifth metacarpal, as in *Elephas*. The trapezoid is the smallest bone in the carpus. The magnum is supported by the lunar, and not at all by the scaphoid. The unciform is the largest carpal bone. It has the usual metacarpal faces well marked, and separated by ridges. The metacarpals are of moderate length, and the third is about equally supported by the magnum and unciform. The articulations for the phalanges are nearly flat, indicating but little motion. The phalanges are very short, and the distal ones rugose.

The pelvis is much expanded, as in Proboscidians. The ilium is suboval in outline. The pubis is slender and short,

and the ischium has less posterior extension than in the elephant. The thyroid foramen is an elongate oval. The femur is proportionally about one-third shorter than that of the elephant. The head of this bone has no pit for the round ligament, and the great trochanter is flattened and recurved. There is no indication of a third trochanter. The distal end of the femur is more flattened transversely than in the elephant, and the condyles are more nearly of the same size. The corresponding articular faces of the tibia are consequently about equal, and also contiguous, with no prominent elevation between them. When the limb was at rest, the femur and tibia were nearly in the same line, as in the elephant and man. The patella is elongate, and oval in outline. The fibula is slender, and entire, with articular faces well marked at each extremity. The astragalus has no distinct superior groove. Its anterior portion has articular faces for both the navicular and cuboid, thus differing from Proboscidians, and agreeing with Perissodactyls. The calcaneum is very short, its longitudinal and transverse diameters being about equal. It does not articulate with the navicular, as in *Elephas*, and has only a small face for the cuboid. There are four well developed digits in the pes, and a rudimentary or small hallux. The metatarsals are much shorter than the metacarpals. The phalanges and sesamoid bones are smaller, but otherwise similar to those of the manus. The hind foot is shown in figure 1 of Plate VI. None of the bones of the skeleton are hollow.

The known species of *Dinoceras* nearly equalled the elephant in size, but the limbs were shorter. The head could reach the ground, and there is no evidence of a proboscis. All the remains of the genus yet discovered are from the Eocene of Wyoming.

Yale College, New Haven, Jan. 18th, 1876.

(To be continued.)

EXPLANATION OF PLATES.

Plate I.—*Dinoceras mirabile* Marsh. Oblique view of skull. One-fifth natural size.

Plate II.—*Dinoceras mirabile* Marsh. Figure 1, side view of skull; figure 2, front view; figure 3, top view. One-eighth natural size.

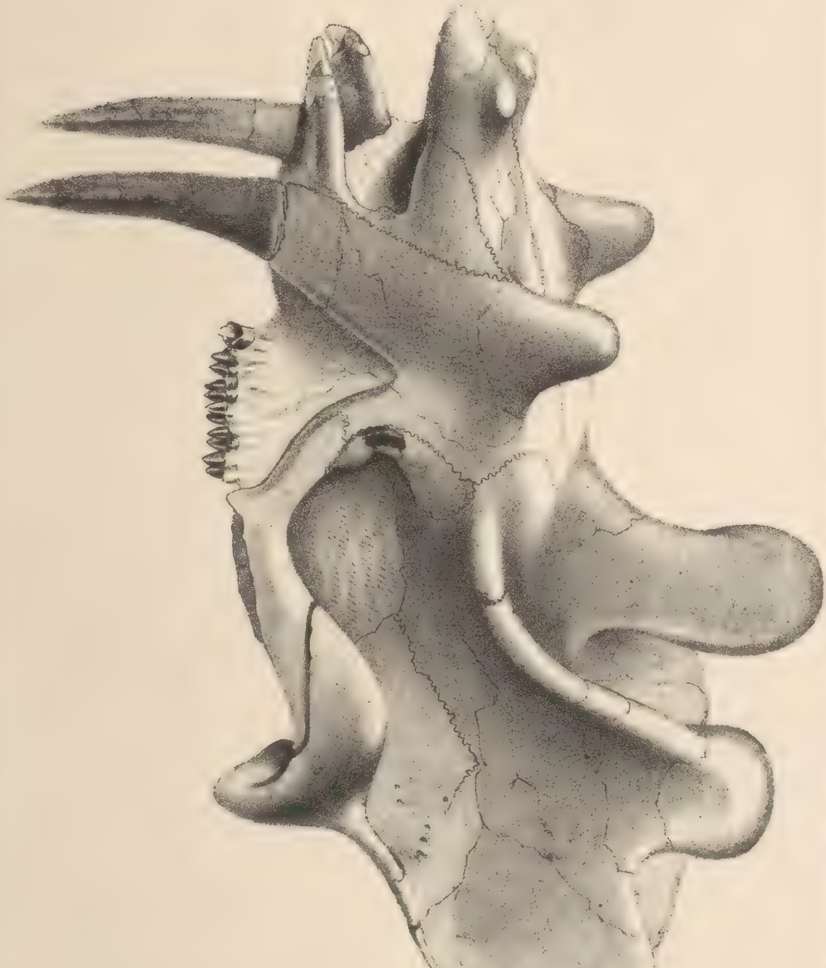
Plate III.—*Dinoceras mirabile.* Superior premolar and molar teeth; bottom view. Three-fourths natural size.

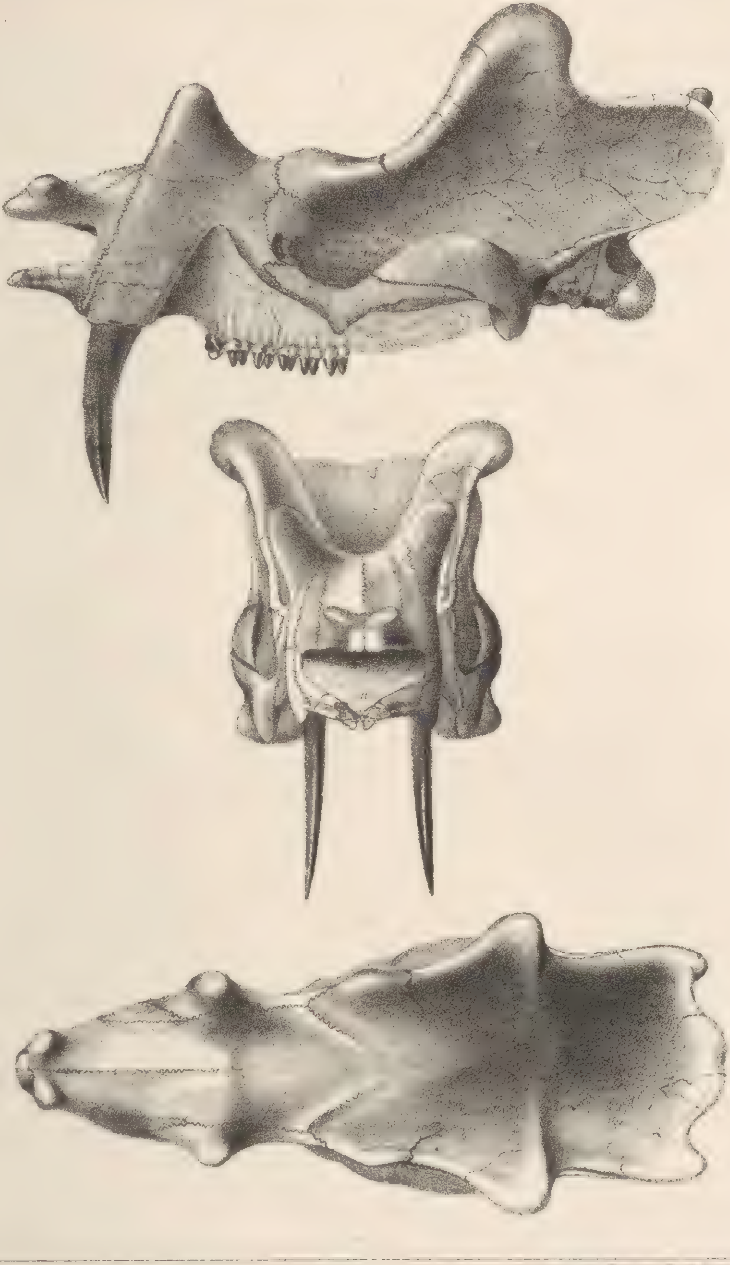
Plate IV.—*Dinoceras mirabile.* Cast of brain cavity. Figure 1, side view; figure 2, top view; figure 3, bottom view. One-half natural size.

Plate V.—*Dinoceras laticeps* Marsh. Lower jaw. Figure 1, front view; figure 2, side view; figure 3, top view. One-fifth natural size.

Plate VI.—*Dinoceras.* Figure 1, hind foot; figure 2, fore foot. One-third natural size.

PLATE I.





Drawn from nature by E. Crisand

DINOCERAS MIRABILE, Marsh. 1/8

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DINOCERAS MIRABILE, Marsh. ½

DINOCERAS LATICEPS Marsh 1/5

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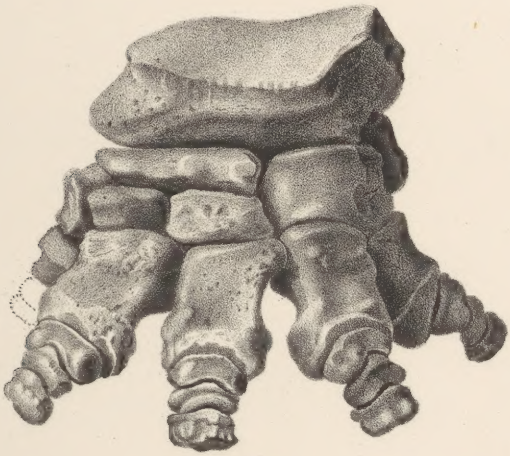

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DINOCERAS ⅓